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SINGLE MODE OPTICAL WAVEGUIDE DESIGN INVESTIGATION.(U)
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(6 SINGLE MODE OPTICAL WAVEGUIDE DESIGN INVESTIGATION,

(9 Progress ~~Report~~ no. 1, Oct-Nov 80,

Submitted to

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Single Mode Optical Waveguide Design Investigation

Progress Report 1

1. Introduction

This report outlines the progress made during the period Oct.-Nov. '80, in carrying out the "Single-mode Optical Waveguide Design Investigation." The report summarizes the work performed in the following areas:

1) Microbend Sensitivity Test
2) Fabrication
3) Equipment Assembly.

2. Microbend Sensitivity Test

One of the main objectives of the program is the testing of the relative sensitivity of various fiber designs to externally applied perturbations. A technique which has been used in previous work at Corning involves pressing the fiber between plates having a nominal 150 grit abrasive applied to them.(1) This technique, used for the multimode fibers, suffers from a rather large variability. To overcome this problem, a new test is being developed to induce the microbends which will hopefully also allow a direct correlation to fiber parameters like the propagation constant β, (2) and the perturbation power spectrum of the fiber/coating system.

The new technique for detemining β of the LP_{11}-mode involves subjecting the waveguide to a perturbation whose curvature can be controlled. This is accomplished by weaving a single-mode fiber through a linear array of pins having known separations as shown in Fig. 1(a). The advantage of this technique is the ability to control the perturbation wavelength Λ_i and its amplitude A_i. This control on the perturbation parameters allows the comparative testing of the microbend sensitivity of the different designs in a direct manner. The different fibers can be subjected to the same curvature perturbation and the resultant loss peaks can be compared. This experiment can be repeated for various Λ_i and A_i to map out the microbend sensitivity over a range of perturbations. The preliminary results, shown in Fig. 2(b), for various perturbation wavelengths show that it is indeed feasibile to correlate the spectral position of the normalized loss peaks indicated in the figure to the perturbation wavelength, Λ_i. This in turn can be correlated with the fiber propagation constant,

$$\beta = n_2 k + \frac{2\pi}{\Lambda_i} \quad . \qquad (1)$$

It is believed that this test will be useful not only for determining the relative sensitivity of various waveguide designs to microbending but also in making a direct comparison with microbending models. Further experiments are in progress to verify the reproducibility of this technique.

3. Fabrication

The initial fabrication work has been oriented toward finding the correct processing parameters for the "center point" of the fiber design matrix given in Table 2 of the proposal, i.e. $\Delta \sim .005\text{-}.007$ and $\lambda_c \sim 1000\text{-}1100$ nm. Four fibers with 250 μm composite acrylate coating have been fabricated to date for this work. A characterization of spectral attenuation in the range (700-1800) nm and cutoff wavelength determination have been performed on these samples. Cutoff wavelengths range from 900 nm to 1100 nm and are thus reasonably on target.

The lowest observed loss was under 2 dB/km. While the source of the somewhat excessive observed loss in the other samples is being investigated, these should nevertheless be sufficiently good for comparative microbend testing to be meaningful providing the other fiber parameters are near their target values. Presently samples are being tested using an electron microprobe to determine whether composition, core size and profile are reasonably correct.

4. Equipment Assembly

A laboratory area for conducting the relative perturbation and splicing sensitivity tests is being prepared. Appropriate fiber mounting and positioning hardware is presently being constructed and assembled. Software for computer acquisition of the data should be completed shortly. It is anticipated that preliminary testing will start in early January.

5. Tasks for Period II

5.1 Completion of experimental equipment assembly.

5.2 Fabrication of fibers covering the central portion of design matrix.

5.3 Reproducibility testing on microbending technique.

REFERENCES

1 "Single-Mode Optical Waveguide Design Investigation," Technical Proposal submitted to NRL, June 6, 1980.

2 V. A. Bhagavatula, "Measurement of Cut-Off Wavelength and Propagation Curve in Single-Mode Waveguides," submitted to IOOC-81, San Francisco, April 1981.

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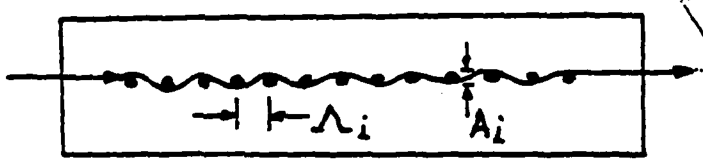
a)



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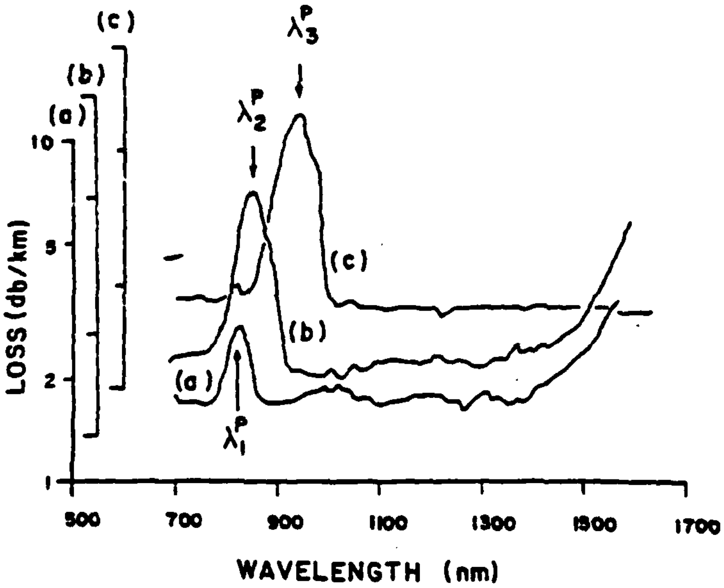

Fig. 1: a) Controllable periodic perturbation with known wavelength Λ_i and amplitude A_i.

b) Normalized transmission loss peaks for various perturbation wavelengths
a) Λ = 3 mm b) Λ = 5 mm c) Λ = 7mm

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